






National Aeronautics and Space Administration

Education Enterprise Strategy

A Message from the Associate Administrator for Education

For nearly 50 years, NASA's proud and dedicated personnel have crossed many frontiers leading to new horizons of opportunity. Our landmark journeys in air and space, brought about by scientific excellence and technical innovation, have deepened mankind's understanding of the universe while also yielding the benefits of advances in air travel, advances in health care technology, and expanded realms for scientific research.

These many achievements ultimately have a common source—education. Every person who has contributed to the advancement and strength of our Nation was inspired at some point with a passion for learning and inquiry. Educators play a pivotal role in creating this inspiration and nurturing it through critical years of development. Each day in the classroom our educators create new horizons of opportunities. They prepare, inspire, excite, encourage, and nurture the exploration for answers and new questions. The culmination of their efforts will be seen years from now in our Nation's laboratories and research centers, and society in general. In this second century of flight, we must maintain our commitment to excellence in science, technology, engineering and mathematics education, to ensure that the next generation of Americans can accept their full roles and responsibilities in shaping our future.

To meet this challenge, NASA has established the Education Enterprise, which will provide students and educators with unique teaching and learning experiences "as only NASA can." Working collaboratively with NASA's Science and Technology Enterprises, the Education Enterprise will promote education as an integral component of every major NASA research and development mission. With guidance from NASA, industry, and university engineers and scientists, students and educators will be studying Earth, exploring the universe and the planets using current data, and conducting scientific experiments using the latest aerospace and space-based research methods. These projects will provide a greater understanding of our home planet and the new technologies being developed to explore the universe and increase our capacity to live and work in space.

As we build upon the accomplishments of America's first century of flight, we are preparing the pathway for the next generation of explorers with great anticipation. These "Explorers of the New Millennium" must fully represent our Nation's vibrant and rich diversity. The NASA Education Enterprise is committed to providing opportunities for all children to explore and develop their full learning potential. We will engage fully the underrepresented and underserved communities of students, educators and researchers. Furthermore, we will support our Nation's universities, colleges, and community colleges by providing exciting research and internship opportunities that will "light the fire" and "fuel the passion" for a new culture of learning and achievement in science, technology, engineering and mathematics.

To echo the words of NASA Administrator Sean O'Keefe, "The greatest mission this Agency has ever accepted is helping to open the mind of a child to unimagined possibilities." We accept this mission with full dedication and deep enthusiasm.

Welcome to NASA's Education Enterprise. Working together, we will fulfill our goal to "see learning in a whole new light."

Adena Williams Loston, Ph.D.
Associate Administrator for Education

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Education Enterprise Strategy

"ONE NASA" EDUCATION

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- Continue student affiliation
- Achieve program excellence
- Expand the pool of human capital

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- Increase elementary and secondary participation
- Enhance higher education STEM capability
- Increase underrepresented and underserved participation
- Expand e-Education
- Expand informal education participation

in implementing this Strategy . . .

- Define education roles and responsibilities
- Restructure programs and manage the portfolio
- Institutionalize evaluation
- Implement "Pathfinder" initiatives

results in the achievement of our goals!

- Inspire and motivate students
- Engage the public

1 Education and NASA's Vision and Mission


SPACE SHUTTLE

1 Education and NASA's Vision and Mission

The NASA Vision—
To improve life here,
To extend life to there,
To find life beyond.

The NASA Mission—
To understand and protect our home planet,
To explore the universe and search for life,
To inspire the next generation of explorers
. . . as only NASA can

The Education Enterprise plays the leading role in NASA's Mission to inspire the next generation of explorers. From the excitement of the countdown to awe-inspiring images of planets and galaxies, aeronautics and space exploration can ignite imaginations young and old. We realize, however, that the journey to space does not start at the launch pad—it starts at the classroom door.

"When it comes to the education of our children . . . failure is not an option."

—President George W. Bush

The NASA Mission—to understand, explore, and inspire—depends upon people with the ingenuity to invent new tools, the passion to solve problems, and the courage to ask difficult questions. To inspire the next generation of scientists, technologists, engineers, and educators, we cannot rely on the past. We must engage the education community and invite them to participate in our ongoing work and process of discovery.

To this end, the Education Enterprise has developed a strategy to inspire and motivate students at all levels to pursue careers in the fields of science, technology, engineering, and mathematics (STEM), as well as teaching. We partner with academic institutions, professional education associations, industry, and other Government agencies to provide teachers and faculty with the experiences that capitalize on the excitement of NASA's discoveries to spark their students' interest and involvement. We provide students with opportunities for involvement in NASA's vast research efforts to promote the STEM disciplines and encourage them to pursue higher education at the graduate and doctorate levels. Finally, we engage the public in shaping and sharing the experiences of exploration and discovery.

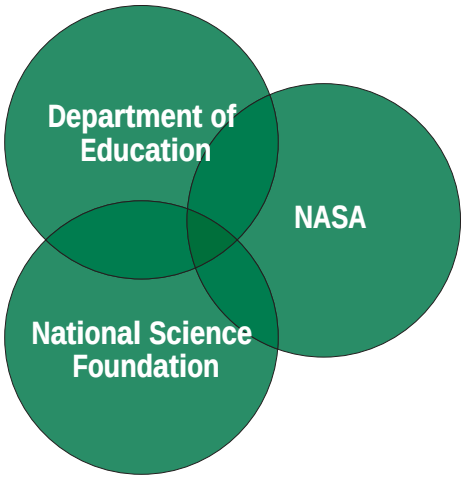
"Today, America has a serious shortage of young people entering the fields of mathematics and science. This critical part of NASA's Mission is to inspire the next generation of explorers so that our work can go on. This educational mandate is an imperative."

—NASA Administrator Sean O'Keefe

NASA offers students and educators unique and unparalleled opportunities for research and educational growth. NASA has an inspiring mission of exploration and discovery, world-class laboratories and facilities, a dedicated and talented workforce, and world-renowned university and industry partners. This wealth of research resources presents students, teachers, and university faculty with unparalleled learning opportunities and experiences—as only NASA can.

NASA's founding legislation directs the Agency to expand human knowledge of Earth and space phenomena and to preserve the role of the United States as a leader in aeronautics, space science, and technology. High achievement in STEM education therefore is essential to the accomplishment of NASA's mission. The Education Enterprise works to align the NASA education strategy with STEM priorities established by the U.S. Department of Education (ED), the National Science Foundation (NSF) (see figure 1.1), and the states, District of Columbia, Commonwealth of Puerto Rico, and U.S. Territories. As one of three Federal agencies with education as a stated mission, NASA plays a unique role in advancing the technical education agenda of our Nation.

Figure 1.1



A core component of NASA's education strategy is to embed education in all research and program activities. The educational efforts within the Science and Technology (S&T) Enterprises—Aerospace Technology, Biological and Physical Research, Earth Science, Space Flight, and Space Science—contribute to the Agency education goals, objectives, and outcomes. The Education Enterprise is responsible for unifying all NASA-sponsored education program activities in the S&T Enterprises, the nine NASA Field Centers, and the Jet Propulsion Laboratory (see figure 1.2), while supporting national and state education goals and objectives.

The academic engagement of students and educators in all facets of aeronautics and space exploration provides skill development and the application of STEM to real world aerospace challenges, thereby grooming the next generation of U.S. scientists and engineers. In conjunction with the NASA Offices of Human Resources and Equal Opportunity, the Education Enterprise will direct its programs to increase the supply of high-achieving STEM graduates prepared to meet the workforce needs of NASA and its industry and university partners.

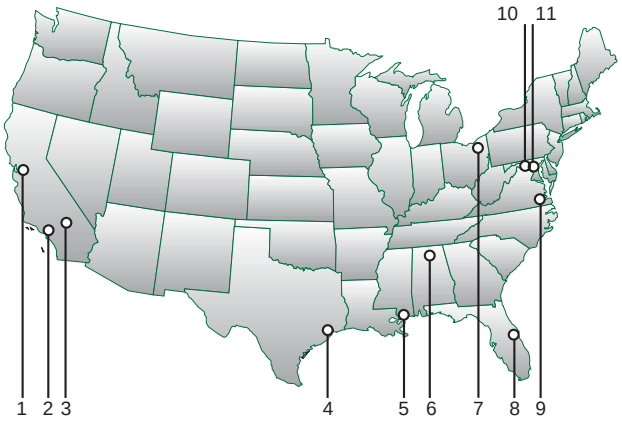


Figure 1.2

1 **Ames Research Center**
2 **Jet Propulsion Laboratory**
3 **Dryden Flight Research Center**
4 **Johnson Space Center**
5 **Stennis Space Center**
6 **Marshall Space Flight Center**
7 **Glenn Research Center**
8 **Kennedy Space Center**
9 **Langley Research Center**
10 **NASA Headquarters**
11 **Goddard Space Flight Center**

As the Education Enterprise orchestrates the development and attainment of the NASA education strategy, we will focus particular attention on students, educators, and researchers from underrepresented and underserved communities and reach out to those who are learning-disabled and physically challenged. Special efforts will be provided for citizens from all communities to access NASA's unique mission, people, and facilities.

Under the leadership of the Education Enterprise, NASA will increase partnerships and alliances with national, state and local education organizations; industry; and academic institutions to encourage and provide access for more students and citizens to become active participants in our exploration of air and space. The Nation's science centers, museums, planetariums, libraries, community-based organizations, and other informal education entities are a major source of inspiration and learning for people from all walks of life. The Education Enterprise will increase the accessibility and availability of engaging content based on NASA's discoveries and exploration and make this content available to the broadest array of informal learning institutions and organizations.

This Strategy describes NASA's approach to transforming its educational programs to contribute to the Agency's Vision and Mission. The Strategy describes the external and internal environment that guides the approach (section 2: Strategic Context and Approach). It establishes strategic goals and objectives and describes the approach to achieving desired outcomes (section 3: Achieving NASA's Education Objectives). It outlines steps to be taken to implement this new direction (section 4: Strategy Implementation). Finally, it provides a vision of NASA's impact on education in the year 2025 (section 5: Beyond the Horizon: Seeing Learning in a Whole New Light).

Building on the strength of a wide array of existing programs, the NASA S&T Enterprises, Field Centers, and Education Enterprise are working together to implement a strategy to support national and state education agendas while accomplishing NASA's Mission to inspire the next generation of explorers. This will allow us to fully realize the educational potential of our Mission to understand, explore, and inspire, increasing the American taxpayers' return on investment in NASA.

To complement their degree program, undergraduate students can intern with NASA.

Education Enterprise Strategy

Our approach . . .

- Integrate student programs into a seamless pipeline
- Continue student affiliation
- Achieve program excellence
- Expand the pool of human capital

2 Strategic Context and Approach

2 Strategic Context and Approach

The NASA 2003 Strategic Plan establishes 10 goals that must be achieved for the Agency to realize its Vision and achieve success in its Mission (see appendix 3).

The Education Enterprise has the lead role in the accomplishment of the goal to "inspire and motivate students to pursue careers in science, technology, engineering, and mathematics" and a strong supporting role in achieving the goal to "engage the public in shaping and sharing the experience of exploration and discovery."

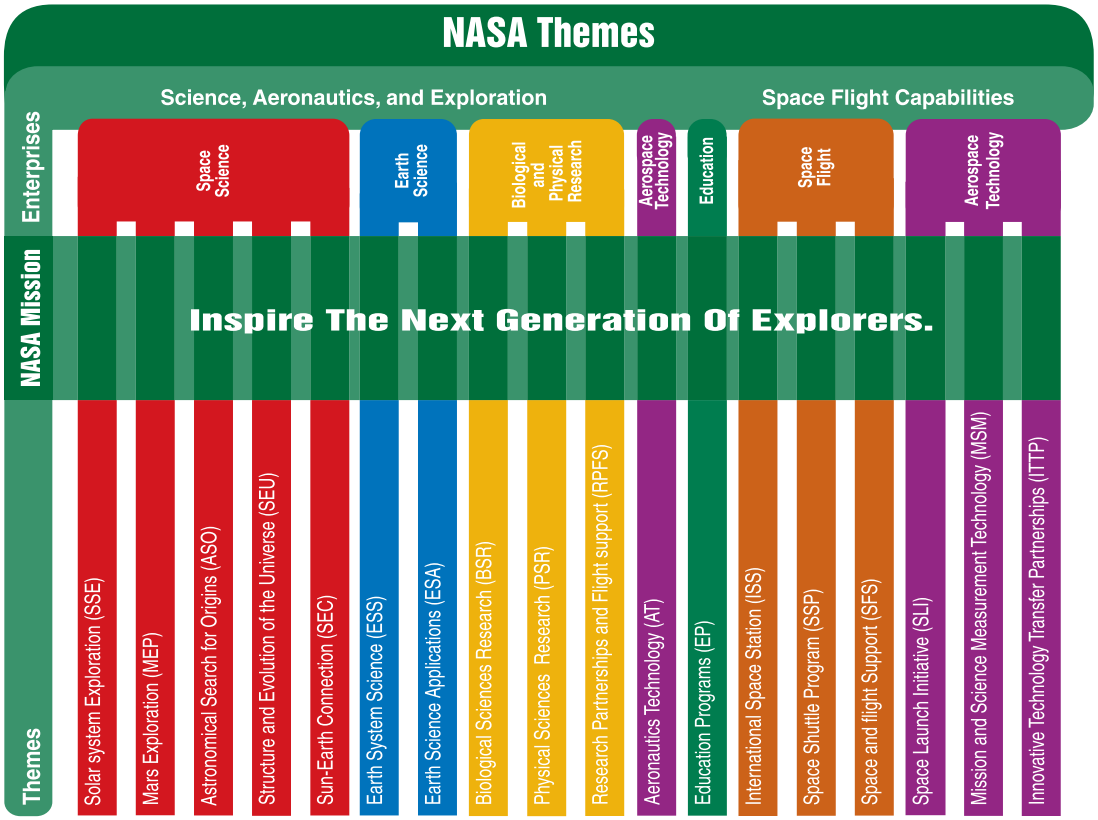
With its ability to capture the imagination of educators, students, and the general public, NASA has a unique capacity to help revitalize science, technology, engineering, and mathematics (STEM) education in America. This will contribute to the continued availability of trained scientists, technologists, engineers, and educators to meet our Nation's technical workforce needs in the 21st century.

"We must look to the American educational system, beginning with our elementary schools and continuing on through undergraduate and graduate education to provide the creative intelligence which is our greatest national resource."

—Former NASA Administrator James E. Webb, address to the National Education Association, Oklahoma City, April 1, 1963

The Education Enterprise serves as a facilitating and integrating agent between the Science and Technology (S&T) Enterprises and the education community. The context for NASA's involvement with the education community is manifested in the rich content represented by the science, aeronautics, and exploration themes, and the space flight capabilities defined in the NASA Strategic Plan, as depicted in figure 2.1.

Figure 2.1



2.1 The Strategic Context in Which We Operate

NASA is committed to sharing the full extent of its scientific discoveries and aeronautics and space exploration with students, teachers, faculty, and the public. NASA's Mission "to inspire the next generation of explorers" builds upon its nearly half-century legacy of supporting education.

High school, undergraduate, and graduate students, working with NASA or university mentors, participate in NASA research.

External Factors and Trends

A lack of public understanding of scientific inquiry, an aging aerospace workforce, a shrinking pipeline of students with science and engineering skills, a shortage of mathematics, science, and technology teachers, and employee recruitment competition put future U.S. advancements in science, aeronautics, and aerospace at risk.

Research studies indicate a decline in the number of students pursuing degrees in the disciplines of science, mathematics, and engineering, which are of critical importance to NASA. Recent National Science Foundation (NSF) reports document the shrinking of science and engineering (S&E) enrollment over the past decade. This trend begins significantly at the secondary level and extends through the ranks of doctoral graduates.

Trends

National Assessment of Educational Progress (NAEP).—In 2000, the NAEP found that 34 percent of fourth graders, 39 percent of eighth graders, and 47 percent of twelfth graders scored "below basic" in science. Similarly, the study found that 31 percent of fourth graders, 34 percent of eighth graders, and 35 percent of twelfth graders scored "below basic" in mathematics. [National Center for Education Statistics, "The Nation's Report Card: Science Highlights: 2000" (Washington, D.C.: U.S. Department of Education, 2002)]

Underrepresented Scores.—At every level of elementary and secondary education, a larger percentage of Caucasian and Asian students scored at least at the "basic" level, as opposed to Black, Hispanic, and American Indian students. In 2000, 69 percent of Black students and 56 percent of Hispanic students scored "below basic" on the NAEP mathematics assessment, while only 26 percent of Caucasian students scored "below basic". Further, Black, Hispanic, and American Indian students drop out of school at a significantly higher rate than Caucasian and Asian students. There was no narrowing of these racial gaps between the 1990 and 2000 NAEP assessments. [National Science Board, "Science and Engineering Indicators: 2002" (Arlington, VA: National Science Foundation, 2002)(NSB-02-01)]

Undergraduate Engineering Enrollment.—The number of students enrolling in undergraduate engineering decreased by more than 20 percent between 1983 and 1999. [National Science Board, "Science and Engineering Indicators: 2002" (Arlington, VA: National Science Foundation, 2002)(NSB-02-01)]

Graduate S&E Enrollment.—Engineering graduate enrollment also declined, from a high in 1992 of 128,854 to 105,006 in 1999. Graduate enrollment in the physical sciences, earth sciences, and mathematics also showed a downturn between 1993 and 2000. [National Science Foundation, "Growth Continued in 2000 in Graduate Enrollment in Science and Engineering Fields" (Arlington, VA: 2001)(NSF-02-306)]

Awarding of Doctoral Degrees.—By the year 2000, the number of doctorates awarded annually in engineering had declined by 15 percent from its mid-decade peak; since 1994, the number of doctorates in physics declined by 22 percent. [National Science Foundation, "Declines in U.S. Doctorate Awards in Physics and Engineering" (Arlington, VA: 2002)(NSF-02-316)]

Foreign S&E Enrollment.—Forty percent of the graduate students in America's engineering, mathematics, and computer science programs are foreign nationals. In the natural sciences, the number of non-citizens is nearly one in four. [National Science Board, "Science and Engineering Indicators: 2002" (Arlington, VA: National Science Foundation, 2002)(NSB-02-01)]

Aerospace Engineering Enrollment.—Graduate enrollment in aerospace engineering has declined steadily in recent years – from 4,036 in 1992 to 3,407 in 2000, suggesting a diminishing interest in that career field. [National Science Board, "Science and Engineering Indicators: 2002" (Arlington, VA: National Science Foundation, 2002) (NSB-02-01) and National Science Foundation, (Arlington, VA: 2001)(NSF-02-306)]

The shrinking S&E education pipeline has great significance to NASA. Nearly 60 percent of the total NASA workforce is in the S&E fields, and half of those employees have masters or doctorate degrees.

Nationally, between 2000 and 2010, employment opportunities in the S&E fields are projected to increase about three times faster than the rate for all occupations, mostly in computer-related fields. Increases in engineering and the physical sciences are projected at 20 percent and 15 percent, respectively. Meanwhile, the number of retirees in these fields is projected to increase dramatically over the next 20 years. Competition for quality S&E workers will intensify as employers seek to fill the vacancies created by these retirements. The advancement of information and computer technologies also creates a need for S&E graduates in the banking, entertainment, and other non-technical industries, thereby impacting the pool of applicants for NASA.

NASA faces the challenge of building a workforce that truly reflects and captures the full potential of the Nation's diversity. In 2003, the NASA S&E workforce mirrors that of the national S&E workforce. Currently, 81 percent of the S&E workforce within NASA is Caucasian, and 81 percent is male. Because the undergraduate S&E pool also lacks diversity to the same or greater extent, NASA is unlikely to improve upon these

NASA is developing materials for students with special needs, such as the *NASA Braille Book of Astronomy*.

demographics without new strategies to attract diverse applicants to the Agency. In addition, NASA faces competition from employers in the private sector, universities, and other government agencies, many of which have the means to offer more competitive compensation. Therefore, the recruitment of minority and female scientists and engineers in the years ahead will be challenging. However, the exciting and unique opportunity afforded by the NASA Mission has an intangible value to prospective scientists and engineers.

The work of the Education Enterprise will be closely linked with NASA's ability to meet its future human capital needs. The Agency is already experiencing skill gaps in mission critical areas such as astrobiology; nuclear, software, and systems engineering; propulsion systems; and space and fundamental physics. Shortfalls also are projected in areas such as aerothermodynamics, robotics, and fundamental space biology.

These trends provide warning signals that significant measures are required for NASA to maintain the competency of its workforce. NASA's Education Enterprise is committed to contributing to a reversal of current negative growth trends in STEM education by demonstrating to students of all backgrounds the value and rewards of careers in science, technology, engineering, mathematics, and teaching.

Education: A NASA Transformation

Guided by a set of core values (see appendix 3), NASA is transforming itself to meet the challenges of the future and achieve its Vision and Mission. In addition to establishing the Education Enterprise, and ensuring that education is an integral part of all our mission programs, other transformations are underway that will impact the alignment of the Enterprise programs with NASA's strategic goals.

Over the years, NASA's achievements have inspired countless individuals from all walks of life. The information age has made our task easier in some ways, but more difficult in others. Today there is increased competition for the minds and imaginations of young people. It has become increasingly difficult to interest students in science, mathematics, engineering, and teaching. We therefore must engage students in our education programs as early as possible.

Table 2.1 reflects how the Education Enterprise will implement the transformations identified in the NASA 2003 Strategic Plan.

Table 2.1

Agency Transformations	Education Program Implementation
All investments will contribute to a shared set of Agency goals and will be directly traceable to our Vision and Mission.	All Enterprises and Centers contribute toward a common set of education objectives, which are defined through common/shared accountability measurements and criteria.
Human space flight capabilities will be expanded to enable research and discovery.	Education programs will utilize human space flight activities and research and development to enhance learning opportunities for students and educators.
Technology developments will be crosscutting.	Education programs will utilize technology to improve student learning and increase access to NASA research and development.
Education and inspiration will be an integral part of all our programs.	The Education Enterprise will work with the S&T Enterprises to ensure education is built into all programs from their inception and is translated into effective education and outreach activities.
We will operate as "One NASA" in pursuit of our Vision and Mission.	We will develop common procedures, capabilities, and tools to ensure that education programs and products capture the essence of NASA and are exciting and relevant to our constituents.

2.2 Our Strategic Approach

The Education Enterprise will expand and implement programs that "build, sustain, and effectively deploy the skilled, knowledgeable, diverse, and high-performing workforce needed to meet the current and emerging needs of government and its citizens," as outlined in the President's Management Agenda. NASA's human capital strategies are linked to the Agency's overall Mission, Vision, core values, goals, and objectives. The Education Enterprise will work in conjunction with the NASA Offices of Human Resources and Equal Opportunity to foster opportunities that support these strategies. Students involved in NASA programs will be engaged in the unique content of NASA's Mission and made aware of NASA-related career opportunities that exist throughout the Agency and with NASA partners in industry and higher education.

The Education Enterprise's strategic approach has three components. First, we will integrate our student programs into a seamless pipeline and encourage ongoing student affiliation with NASA. Second, we will ensure program excellence in everything we do through the establishment of the program operating principles. Finally, we will expand the pool of human capital to meet the needs of NASA and its partners.

Integrate Student Programs into a Seamless Pipeline and Encourage Continued Student Affiliation

Expanding the pool of human capital to meet the needs of NASA and our partners requires us to transform the operation of our student programs. Until now, most of these programs have operated independently and have not emphasized how students can remain engaged with NASA throughout their academic career. As a result of our program evaluation in FY03, steps are underway to provide better coordination and communication among NASA's student programs. Such program linkages will ensure that students who are engaged in NASA learning experiences will be kept informed of new opportunities for which they may compete as they continue their studies. As part of this strategic approach to integrating our programs into a seamless pipeline, NASA has developed an Agencywide tracking system of student participation in its education programs. First, this tracking system facilitates more effective ongoing communication with students and dissemination of future program opportunities. Second, the tracking system also will be used to identify potential candidates for organizational vacancies. Finally, the system will be used to evaluate the effectiveness of student programs in meeting NASA's human capital needs.

High school students participating in NASA programs have the opportunity to continue their affiliation with NASA at the undergraduate and graduate levels.

Achieve Program Excellence: Education Operating Principles

Our goal to "inspire the next generation of explorers" requires excellence in all of our educational efforts with students, teachers, faculty, and institutions. Therefore, to ensure program alignment and excellence, the Education Enterprise has established operating principles. Every NASA-sponsored education program or activity in elementary and secondary education, higher education, and informal education is developed, implemented, and evaluated according to the six principles listed in table 2.2.

These principles are expected to be represented within each of NASA's education programs, regardless of whether they are implemented by Enterprises, NASA Field Centers or through contracts, grants, or cooperative agreements. Program excellence will be determined by adherence to these six operating principles.

Expand the Pool of Human Capital to Meet NASA Human Resource Needs

NASA has succeeded in creating a broad and diverse range of student programs, but we need to do more. Increasing the number of students that become inspired to study and enter into STEM and teaching career fields requires us to expand our existing opportunities while creating new opportunities. By embedding education opportunities into every NASA flight and research mission, we can increase greatly the number of students that are inspired, motivated, and intellectually prepared to contribute to the NASA Mission.

Table 2.2

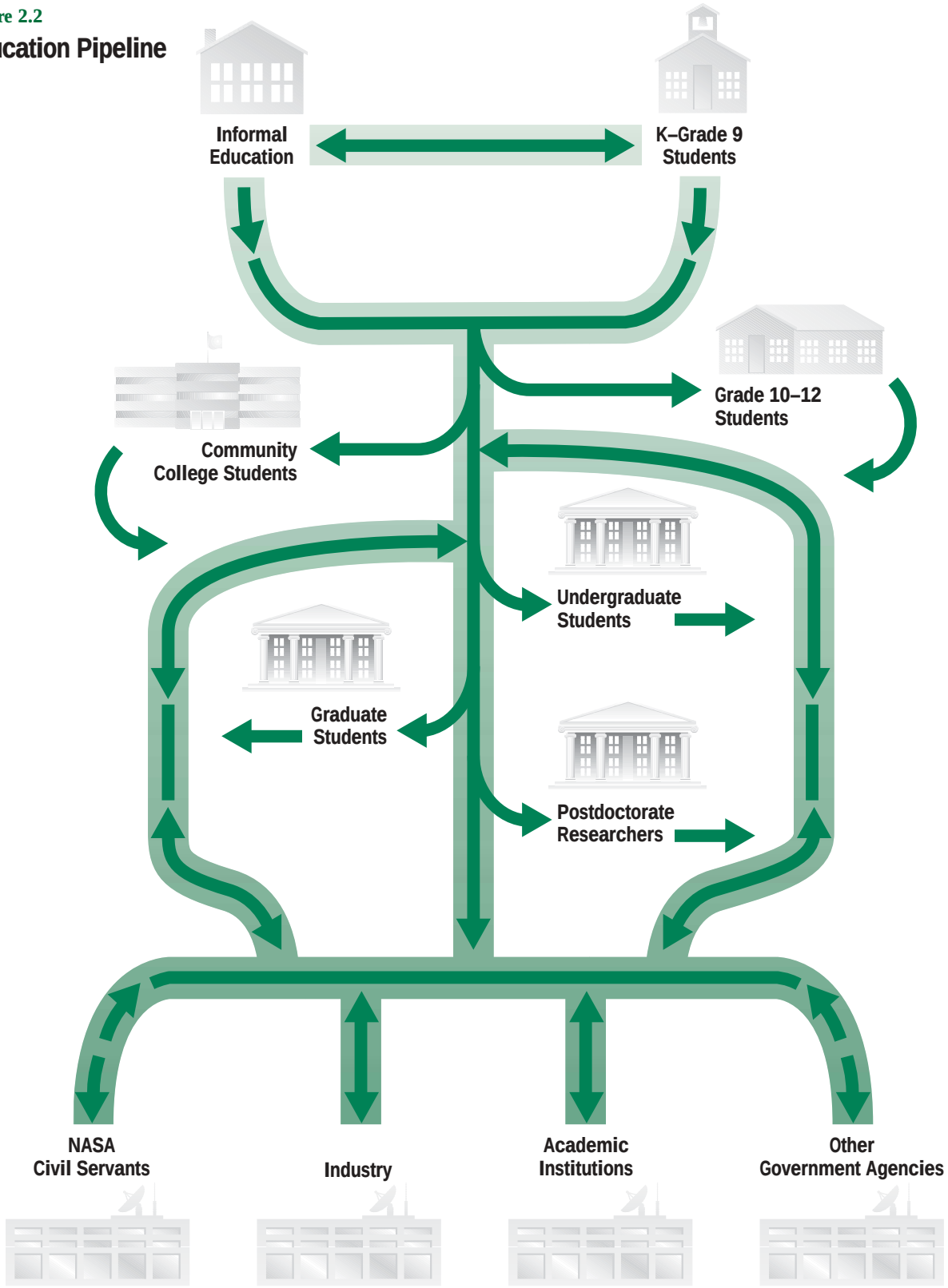
Education Program Operating Principles[1]

Customer Focus:	Programs have been designed to respond to a need identified by the education community, a customer, or a customer group.
Content:	Programs make direct use of NASA content, people, or facilities to involve educators, students, and/or the public in NASA science, technology, engineering, mathematics.
Pipeline:	Programs make a demonstrable contribution to attracting diverse populations to careers in science, technology, engineering, mathematics.
Diversity:	Programs reach identified targeted groups.
Evaluation:	Programs implement an evaluation plan to document outcomes and demonstrate progress toward achieving objectives.
Partnerships/ Sustainability:	Programs achieve high leverage and/or sustainability through intrinsic design or the involvement of appropriate local, regional, or national partners in their design, development, and dissemination.

[1]These criteria directly address programs only. However, products should also be evaluated using standard criteria.

Figure 2.2

Education Pipeline



Education Enterprise Strategy

Our approach . . .

- Integrate student programs into a seamless pipeline
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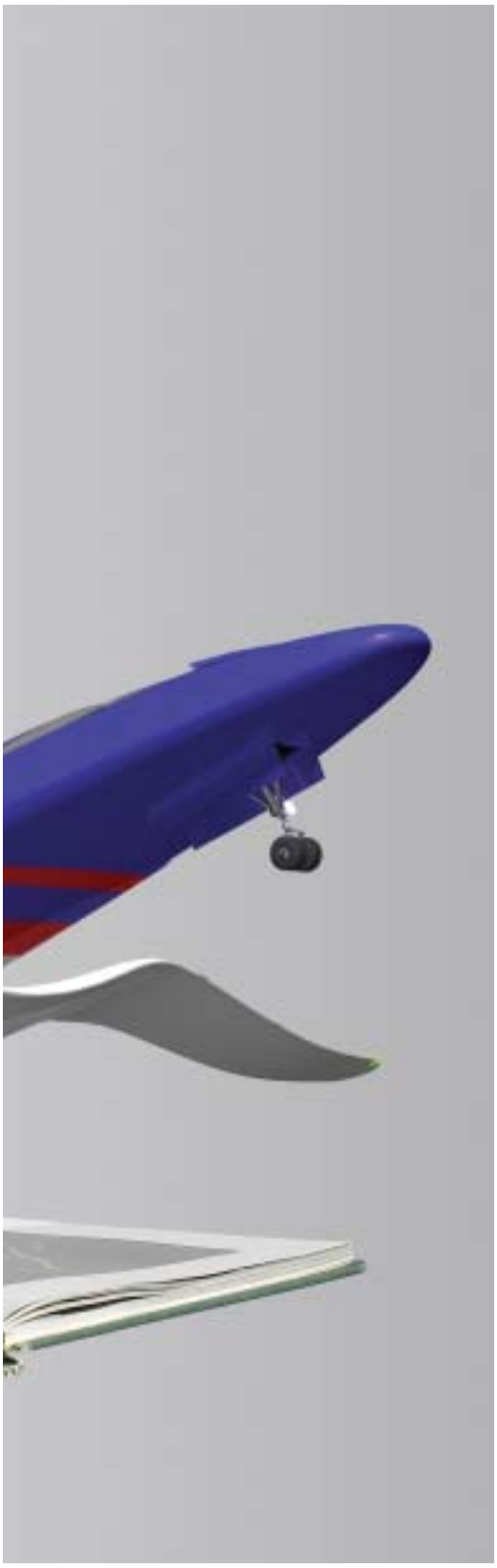
to achieving our objectives . . .

- Increase elementary and secondary participation
- Enhance higher education STEM capability
- Increase underrepresented and underserved participation
- Expand e-Education
- Expand informal education participation

3 Achieving Education Objectives



3 Achieving Education Objectives

Consistent with the strategic context and approach defined, the two main goals of NASA's education program are to "inspire and motivate students to pursue careers in science, technology, engineering, and mathematics" by supporting education in the Nation's schools and to "engage the public in shaping and sharing the experience of exploration and discovery" by supporting informal education and public outreach efforts. NASA's commitment to education places special emphasis on these goals by increasing elementary and secondary education participation in NASA programs; enhancing higher education capability in science, technology, engineering, and mathematics (STEM) disciplines; increasing participation by underrepresented and underserved communities; expanding e-Education; and expanding NASA's participation with the informal education community.

"This is the 21st century. Ours is a world of 24-hour news cycles, global markets, and instant messaging. Our education system should reflect the times we're living in."

—U.S. Secretary of Education Rod Paige

The Education Enterprise will continue to support NASA's strong historical role in education at all levels, with linkages to NASA research as a central part of our focus. The majority of NASA support to higher education is delivered through the Science and Technology (S&T) Enterprises.

The Education Enterprise supports the work of the S&T Enterprises by coordinating programs for students, faculty, and institutions that broaden the base of those who compete for NASA research awards. These efforts will help create and sustain the scientific and engineering workforce of the future. In addition, the Education Enterprise will continue to emphasize sharing the results of NASA missions and research programs with wider audiences by using science discoveries and research applications as vehicles to improve teaching and learning at all levels.

3.1 Education Enterprise Strategic Framework

Each NASA Enterprise and Field Center plays a critical role in the achievement of NASA's strategic mission goals. In general, program requirements are distributed to these entities and their accomplishments, as measured by metric data, are reported for analysis to measure overall Agency performance against these goals (see figure 3.1).

Toward this end, the Education Enterprise, in collaboration with the S&T Enterprises and the Field Centers, ensures that the education hierarchy components (see figure 3.2) are aligned with the NASA Strategic Plan, and that the Education strategy planning process (see figure 3.3) is comprehensive and consistent.

Figure 3.1

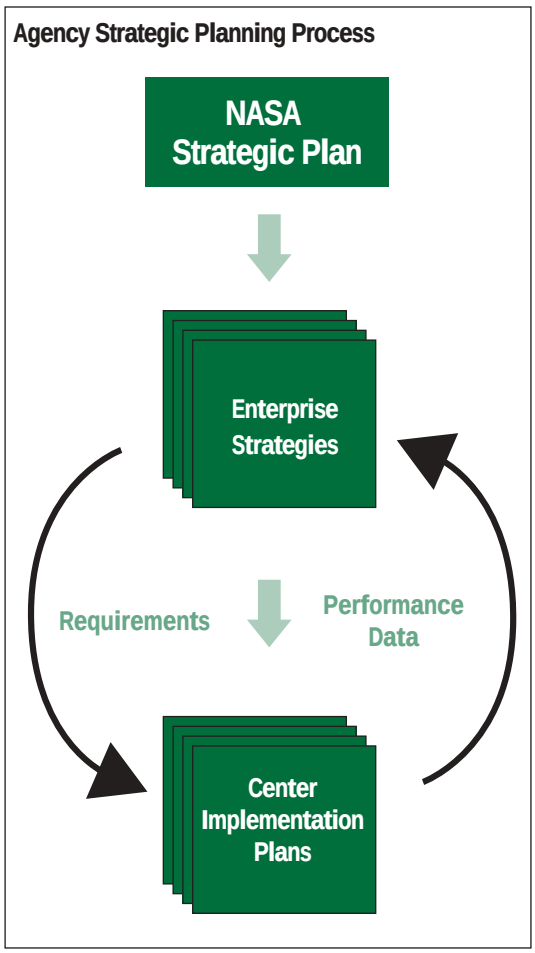
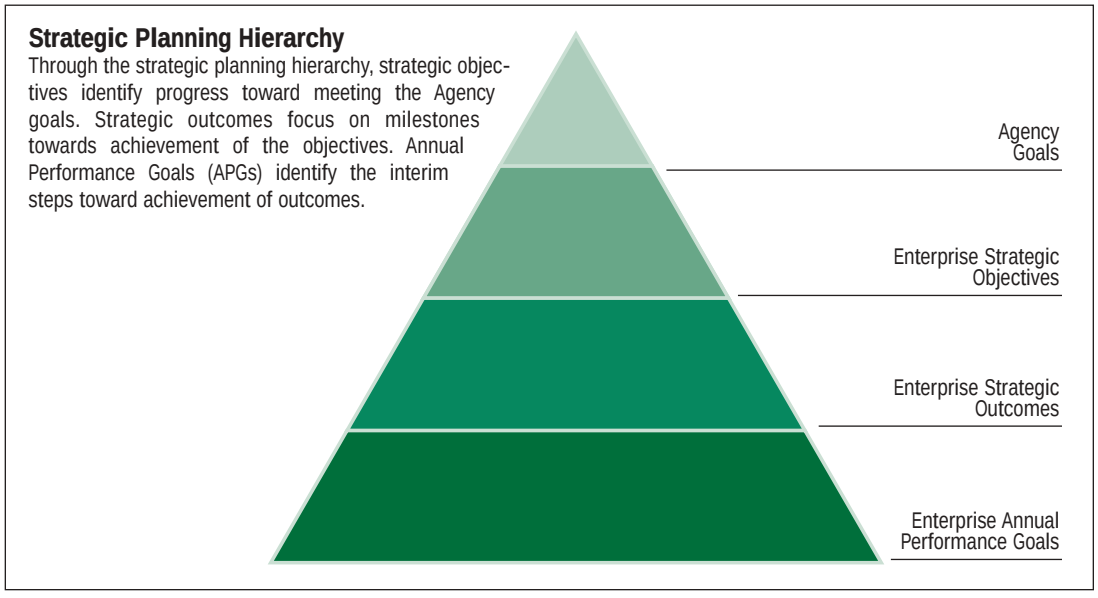


Figure 3.2



The "NASA SCIence Files™," a distance-learning program, integrates and enhances the teaching of science, technology, and mathematics.

Figure 3.3

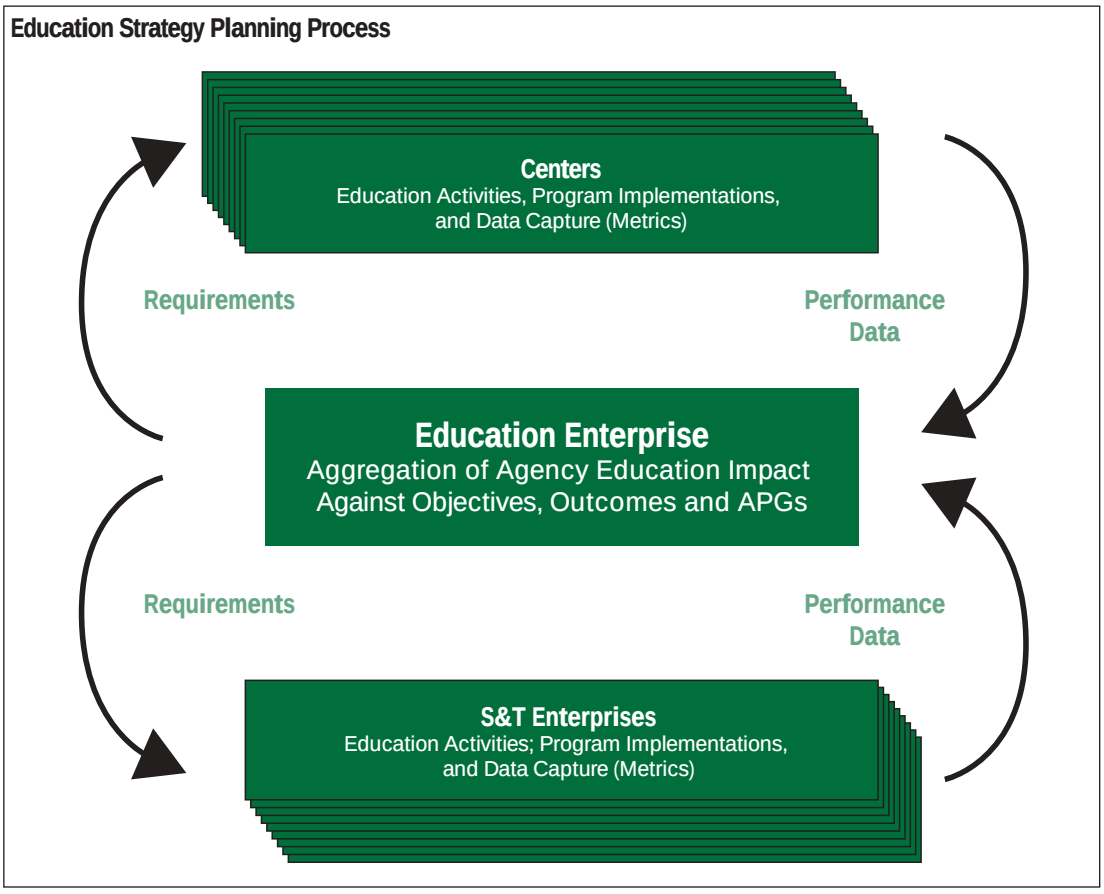


Table 3.1

Education Strategic Goals, Objectives, and Outcomes[1]

Goal 6.—Inspire and motivate students to pursue careers in science, technology, engineering, and mathematics (STEM)				Goal 7.—Engage the public in shaping and sharing the experience of exploration and discovery
Strategic Objectives				
6.1 Elementary and Secondary Participation	6.2 Higher Education Capability	6.3 Underrepresented and Underserved Participation	6.4 e-Education	7.1 Informal Education
Strategic Outcomes				
6.1.1 Student Participation	6.2.1 Student Pipeline	6.3.1 Student Pipeline	6.4.1 Education Technology R&D	7.1.1 National Program
6.1.2 Educator Support	6.2.2 Faculty Competitiveness	6.3.2 Teacher/Faculty Support	6.4.2 Learning Tools and Materials	7.1.2 Instructional Materials
6.1.3 Family Support	6.2.3 Preservice Education	6.3.3 Researcher and Institutional Support	6.4.3 Digital Learning/ Content Services	7.1.3 Professional Development
6.1.4 Institutional and Systemic Support	6.2.4 Student Research	6.3.4 Family Support		
Annual Performance Goals (APGs)				
Developed annually through the budget process.				

[1] The Education Enterprise strategic objectives, strategic outcomes, and annual performance goals were developed collaboratively by NASA senior education leadership representing the Office of Education, the Science and Technology Enterprises, and the NASA Centers. While Annual Performance Goals are crucial to the measurement of progress and performance against outcomes, objectives, and goals, they are shorter-term in nature and are more appropriately the focus of the annual budget process.

3.2 Strategic Objectives and Outcomes

Table 3.1, shown above, outlines the NASA education strategic goals, objectives and outcomes.

NASA Strategic Goal 6.—Inspire and motivate students to pursue careers in science, technology, engineering, and mathematics.

To help prepare a new generation of Americans to pursue challenging careers in STEM and teaching, the Education Enterprise has four objectives, described in the sections to follow. These objectives focus on the educational pipeline from the elementary to post-secondary levels. They include an emphasis on e-learning, and stress participation by underrepresented and underserved populations.

Making "ice-cream comets" helps young students understand the application of mathematics and science in space exploration.


JPL

Strategic Objective 6.1.—Increase the number of elementary and secondary students and teachers who are involved in NASA-related education opportunities.

NASA believes that by increasing the number of students involved in NASA-related activities at the elementary and secondary education levels more students will be inspired and motivated to pursue higher levels of study in STEM courses.

To achieve this objective, NASA will engage students, educators, families, and institutions. When students are inspired, they are motivated to learn more and assume more difficult challenges, such as those posed in the study of higher levels of mathematics and science. To continue challenging these students, educators must be provided with the tools, experiences, and opportunities to further their education and participate in unique NASA learning experiences to enhance their knowledge of STEM. NASA programs will emphasize family involvement, which has been shown to enhance student achievement. Finally, NASA will support the role of educational institutions, which provide the framework to unite students, families, and educators for educational improvement.

Objective 6.1
Elementary and Secondary Participation

Objective

Increase the number of elementary and secondary students and teachers who are involved in NASA-related education opportunities.

Outcome

Outcome 6.1.1: Student Participation
By 2008, increase by 20 percent student participation in NASA instructional and enrichment activities.

Outcome 6.1.2: Educator Support
By 2008, increase by 20 percent the number of elementary and secondary educators effectively utilizing NASA content-based STEM materials and programs in the classroom.

Outcome 6.1.3: Family Support
By 2008, increase by 20 percent family involvement in NASA-sponsored elementary and secondary education programs.

Outcome 6.1.4: Institutional and Systemic Support
By 2008, 90 percent of NASA elementary and secondary programs are aligned with state or local STEM educational objectives.

Participation in NASA-related activities make classroom concepts come alive for young students.

Strategic Objective 6.2.—Support higher education research capability and opportunities that attract and prepare increasing numbers of students and faculty for NASA-related careers. The Education Enterprise is strengthening involvement with higher education institutions to ensure that NASA can meet future workforce needs in the STEM fields. Participation in NASA programs and research will influence increasing numbers of students to continue their studies and earn advanced degrees in these critical fields.

NASA will facilitate improved coordination between NASA-sponsored university research activities and teacher preparation programs. This will expose teachers-in-training to NASA research and discoveries, thus furthering their understanding of STEM disciplines.

Through faculty development opportunities, NASA will increase the candidate pool of qualified faculty and institutions who can compete for NASA research awards.

Objective 6.2
Higher Education Capability

Objective

Support higher education research capability and opportunities that attract and prepare increasing numbers of students and faculty for NASA-related careers.

Outcome

Outcome 6.2.1: Student Pipeline
By 2008, attain a statistically significant increase in the number and diversity of NASA-supported students graduating in NASA-related fields.

Outcome 6.2.2: Faculty Competitiveness
By 2008, attain a statistically significant increase in the number of faculty in higher education institutions who are first-time proposers in NASA research and development opportunities.

Outcome 6.2.3: Preservice Education
By 2008, increase by 20 percent the number of higher education institutions that align their NASA-funded research with STEM teacher preparation departments to improve STEM teacher quality.

Outcome 6.2.4: Student Research
By 2008, increase by 10 percent the number and diversity of students conducting NASA-relevant research.

The NASA workforce of tomorrow is being trained today in our institutions of higher education.

Strategic Objective 6.3.—Increase the number and diversity of students, teachers, faculty, and researchers from underrepresented and underserved communities in NASA-related STEM fields. The Education Enterprise strives to ensure that underrepresented and underserved students participate in NASA education and research programs to encourage more of these students to pursue STEM careers. NASA recognizes the role of teachers, faculty and families in the development of successful students.

The Education Enterprise will continue to focus on enhancing the capabilities of Historically Black Colleges and Universities (HBCUs), Hispanic Serving Institutions (HSIs), and Tribal Colleges and Universities (TCUs) to contribute to the research needs of the S&T Enterprises. The Education Enterprise also will work to encourage these institutions to collaborate with teacher preparation programs to improve the quality and diversity of STEM teachers.

Objective 6.3
Underrepresented and Underserved Participation

Objective

Increase the number and diversity of students, teachers, faculty, and researchers from underrepresented and underserved communities in NASA-related STEM fields.

Outcome

Outcome 6.3.1: Student Pipeline
By 2008, increase by 20 percent underrepresented/underserved NASA-sponsored students who pursue academic degrees in NASA-related STEM disciplines.

Outcome 6.3.2: Teacher/Faculty Support
By 2008, increase by 20 percent the number and diversity of teachers and faculty from underrepresented/underserved communities and institutions who participate in NASA-related STEM programs.

Outcome 6.3.3: Researcher and Institutional Support
By 2008, increase by 20 percent the number of underrepresented/underserved researchers and minority-serving institutions that compete for NASA research and development opportunities.

Outcome 6.3.4: Family Support
By 2008, increase family involvement in underrepresented/underserved NASA-sponsored student programs.

NASA-sponsored workshops are designed to increase STEM teacher proficiency within the underrepresented and underserved communities.

Strategic Objective 6.4.—Increase student, teacher, and public access to NASA education resources via the establishment of e-Education as a principal learning support system.
NASA will work to develop new methods of making its exciting discoveries and valuable resources available to students, educators, and researchers. Developing a delivery system that is timely and accurate while protecting the intellectual capital of research scientists is a continuing challenge. NASA is committed to finding the right balance in this challenge so that education customers continue to have access to NASA's engaging science content through digital media.

Objective 6.4
e-Education

Objective
Increase student, teacher, and public access to NASA education resources via the establishment of e-Education as a principal learning support system.

Outcome
Outcome 6.4.1: Education Technology R&D
By 2008, identify and implement four new advanced technology applications that will positively impact learning.

Outcome 6.4.2: Learning Tools and Materials
By 2008, demonstrate the effectiveness of NASA digital content materials in targeted learning environments.

Outcome 6.4.3: Digital Learning/Content Services
By 2008, establish a technology infrastructure that meets citizen demand for NASA learning services.

NASA Strategic Goal 7.—Engage the public in shaping and sharing the experience of exploration and discovery.
Effective public engagement is one of NASA's primary goals. The Education Enterprise plays a fundamental role in achieving this through partnerships with informal education institutions, which are a major source of inspiration and learning for people from all walks of life.

Strategic Objective 7.1.—Improve public understanding and appreciation of science and technology, including NASA aerospace technology, research, and exploration missions.
As the technological world changes, scientific literacy in the general population is essential to ensure that decisions affecting our daily lives are made wisely. NASA scientific discoveries, technological breakthroughs, and spin-offs that are relevant to our daily lives need to be better communicated to the public as a whole. In cooperation with the S&T Enterprises, the Education Enterprise will leverage partnerships with our existing and future informal education partners to share our discoveries and experiences. The Education Enterprise will develop a plan and implement a national program to engage science

Objective 7.1
Informal Education

Objective
Improve public understanding and appreciation of science and technology, including NASA aerospace technology, research, and exploration missions.

Outcome
Outcome 7.1.1: National Program
By 2008, establish a national program to engage the informal education community with NASA science and technology.

Outcome 7.1.2: Instructional Materials
By 2008, provide instructional materials derived from NASA research and scientific activities that meet the needs of NASA's informal education partners.

Outcome 7.1.3: Professional Development
By 2008, provide professional development for NASA's informal education partners.

centers, museums, planetariums, community-based organizations, and other public forums to assist us in sharing our discoveries. The Education Enterprise will facilitate development of educational materials that incorporate these new discoveries and disseminate them to our partners. In addition, NASA will work with our partners to help develop and deliver professional development programs for educators. A more science-literate society can make better decisions to help define the technological developments that will shape the future.

NASA and the informal education community partner to bring exploration to the museum floor.

Education Enterprise Strategy

Our approach . . .

- Integrate student programs into a seamless pipeline
- Continue student affiliation
- Achieve program excellence
- Expand the pool of human capital

to achieving our objectives . . .

- Increase elementary and secondary participation
- Enhance higher education STEM capability
- Increase underrepresented and underserved participation
- Expand e-Education
- Expand informal education participation

in implementing this Strategy . . .

- Define education roles and responsibilities
- Restructure programs and manage the portfolio
- Institutionalize evaluation
- Implement “Pathfinder” initiatives

4 Strategy Implementation

4 Strategy Implementation

NASA's implementation of its education strategy consists of defining the roles of NASA organizations involved in education programs, establishing an evaluation and research function as a core component, realigning the education program portfolio, and defining the "pathfinder" strategic initiatives that embody this transformation.

"Christa McAuliffe articulated the enthusiasm of all teachers when she explained: 'We touch the future, we teach.' We now all have the opportunity to 'touch the future' by committing our Nation's technological expertise, limitless imagination, and energy to empowering America's teachers and students."

—"2020 Visions: Transforming Education and Learning Through Advanced Technology," U.S. Department of Commerce

4.1 Roles of the Component Organizations

A "One NASA" approach to education requires an understanding of the roles of each of the Agency's component parts that contribute to an integrated education strategy.

Close and effective collaboration among the Education Enterprise, the Science and Technology (S&T) Enterprises, and the education offices of the NASA Field Centers is critical to the fulfillment of NASA's education strategy. Through this collaboration, NASA's research, technologies, facilities, and discoveries can be transformed into valuable resources that support educational excellence across the Nation.

Through the implementation of a unified strategy for education, certain roles and responsibilities emerge as common to all organizations. The common understanding of these roles and responsibilities enables the achievement of a coherent and coordinated education strategy.

First, the phrase "as only NASA can" provides the fundamental guiding principle for our educational efforts. Essentially, NASA education programs will be centered around and draw upon NASA's unique assets:

- **Mission** results and research and development programs
- **People**, including NASA employees and the larger scientific, technical, and engineering communities who are major participants in NASA programs
- **Facilities**, including world-class, ground-based and in-orbit laboratories

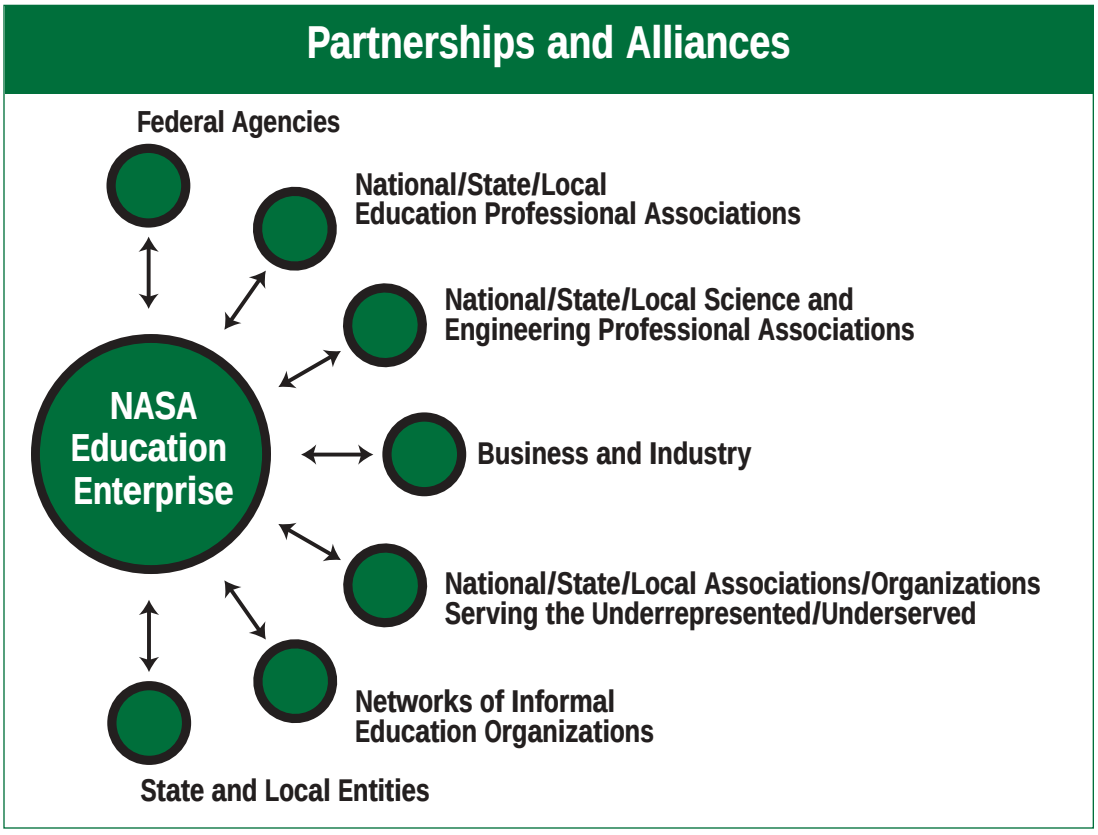
Second, the operating principles (see table 2.2) ensure a direct connection to the NASA Strategic Plan and alignment with specific NASA strategic objectives for education. The principles do the following:

- Function as criteria against which proposals for new education initiatives will be judged
- Enable appropriate mid-course corrections
- Form the basis for evaluating programs
- Document program success

Third, the NASA Education Enterprise partners with external agencies and organizations (figure 4.1) to ensure that NASA meets its education customers' needs and leverages NASA's impact.

Partnerships and alliances with national, state, and local education associations—representing teachers, faculty, and administrators who are

Figure 4.1



knowledgeable about school curricula and standards—guide elementary, secondary, and post-secondary program development and implementation. National, state, and local associations, organizations, and institutions—which are knowledgeable about the needs and capabilities of underrepresented and underserved populations—guide all program development and implementation. National, state, and local associations of science and engineering professionals—who are knowledgeable about workforce development and training issues—guide higher education program development and implementation. Networks of informal education organizations—which are knowledgeable about the comprehensive missions of museums, science centers, and community-based groups—help shape public science literacy efforts.

Partnerships with Federal agencies promote alignment with national STEM priorities; partnerships with state and local entities enhance alignment with state and local agendas; and partnerships with business and industry ensure alignment with national human capital priorities.

These partnerships and alliances multiply the impact of NASA's education programs by leveraging knowledge, identifying additional target audiences and organizations, and sharing program resources.

The Role of the Education Enterprise

The Education Enterprise provides Agency leadership by establishing the direction, policy, annual priorities, and guidance for NASA's education program. The Enterprise establishes and communicates program guidance and operating principles; conducts program assessment and evaluation, budget formulation, and execution; interacts with Congress and the Office of Management and Budget; and plans and implements interagency agreements. In addition, the Enterprise initiates and develops partnerships with national education organizations, universities, and business and industry partners that directly support the education program.

Another role of the Enterprise is to ensure that the education investments sponsored by the S&T Enterprises and Centers align with its education strategy. The Enterprise is responsible for conceiving and directing Agencywide programs that are national or multi-regional in scope. Such programs may be implemented nationally, such as the National Space Grant College and Fellowship Program (Space Grant) and the Experimental Program to Stimulate Competitive Research (EPSCoR), or through NASA Centers, such as the University Research Centers (URC) and fellowship and scholarship programs for graduate and undergraduate students.

The Enterprise is responsible for defining the evaluation requirements and performance metrics for all education programs. This ensures that output and outcome data are collected in a coordinated, systematic way and that program resources are allocated based on alignment and performance. These results can be aggregated to demonstrate the total impact of NASA education efforts and assessed to improve the overall program investment strategy.

To help coordinate NASA's education programs throughout the Agency and its Enterprises, the Education Enterprise has established an education lead position for each of the S&T Enterprises at NASA Headquarters.

The Role of the Science and Technology Enterprises

The S&T Enterprises are responsible for embedding education components into their flight missions and research programs. Education must become a fundamental part of all NASA science, technical, and engineering activities to fully realize the NASA mission of inspiring the next generation of explorers "as only NASA can."

Embedding education in NASA's flight missions and research programs means, in practice, that many of the Agency's education programs will be carried out through the S&T Enterprises, in collaboration with the Education Enterprise and the NASA Centers. Each Enterprise will support the NASA education program by providing expertise, funding, and human resources to plan and implement educational programs, products, and services that reflect the particular scientific and technology content of the Enterprise.

The unique content of the Agency's strategic themes (see figure 2.1) represent the possibilities of "as only NASA can" for the education community. Each S&T Enterprise contains a wealth of content that can be used to create unique, engaging programs and learning materials. The Education Enterprise is responsible for creating and managing a balanced program portfolio that features content from all S&T Enterprises. For their part, the S&T Enterprises are responsible for guiding the Education Enterprise as it integrates new discoveries into NASA's education programs and activities.

Each S&T Enterprise has a co-located education lead who has extensive knowledge of both NASA education programs and the research and development of their respective office. Enterprise education leads do the following:

- Advocate education in the S&T Enterprises
- Develop Enterprise education activities that support and directly contribute to the overarching NASA education strategic objectives and outcomes
- Facilitate the incorporation of education components into Enterprise research, developments and flight programs
- Ensure Enterprise education programs are designed for and reach diverse audiences
- Contribute to annual performance goals that support the overall NASA education program
- Monitor Enterprise research developments and discoveries and ensure that they are incorporated into the broader NASA education programs

There are many examples of education programs currently managed and implemented by the S&T Enterprises that exemplify this role. The GLOBE program is an international science and education program that unites students, teachers, and scientists in the study of Earth system science. The Mars Student Imaging Project engages precollege and undergraduate students in acquiring images and analyzing data from the Mars Odyssey Spacecraft. The Enhanced Gaseous Nitrogen Dewar Student Flight Program teams students and teachers with NASA physical scientists to conduct ground experiments in their school that are analogous to a flight project. *NASAexplores*, a Web-based resource offering weekly elementary- and secondary-level math, science, and technology curriculum supplements, engages NASA engineers in bringing the world of aeronautics and space flight to teachers and students.

The Role of the NASA Centers

The education offices of the NASA Centers participate in the planning and implementation of Agency-level education programs and lead the development of education programs that are unique to their Centers. They are responsible for communicating Education Enterprise policies and strategies and implementing national programs.

At the elementary and secondary level, each Center is responsible for a specific geographic region. This ensures that Center education staff are familiar with and responsive to state and local needs, policies, and programs.

NASA education programs engage students in a wide range of research applications, such as lunar or Mars rover experiments.

Students participating in NASA programs work with experienced mentors who help put STEM concepts into action.

Center education offices recognize NASA's important relationship with the state and local education community. The Centers support these customers rather than supplanting the school's role as the primary agent for children's learning. The Centers work closely with this customer base in support of systemic reform initiatives in formal education, assist with the generation and communication of knowledge through the higher education infrastructure, and establish linkages with informal education networks in support of the Agency national STEM initiatives.

At the higher education level, Centers reach out to involve colleges and universities across the country. Students, researchers, and faculty are competitively selected for assignments and opportunities that match their discipline, expertise, and interests with the unique research requirements and challenges at each Center.

Center education offices play a key role in the development of the Center Implementation Plans to ensure that Education Enterprise strategies are incorporated and supported throughout the work of the NASA Centers. They also ensure that their unique programs integrate the themes and discoveries of the S&T Enterprises.

The Role of NASA Public Affairs in Education

As NASA elevated the status of education to an Agency priority, it also intensified efforts to achieve its educational objectives in part by increasing public awareness. By adding a dedicated Headquarters public affairs officer and assigning the education "beat" to public affairs officers at the NASA Field Centers, NASA has primed the Education Enterprise to reach out effectively to students, educators, and parents through enhanced media placement, special events, and strategic public appearances by NASA officials at education venues across the country.

The public affairs communication plan will complement the Education Enterprise strategy as an integral component to overall Education Enterprise outcomes.

4.2 Program Restructuring and Portfolio Management

NASA has supported education throughout its storied history. The Agency's programs today include the Minority University Research and Education Program—which broadens the participation of underrepresented minorities and minority institutions in NASA research—and the Space Grant program—which supports NASA research, the training of undergraduate and graduate students, and public service programs in all 50 states, the District of Columbia, and the Commonwealth of Puerto Rico. The NASA Space Science, Earth Science, and Biological and Physical Research Enterprises each engage their scientific communities to bring the knowledge of new discoveries to classrooms and campuses while the Aerospace Technology and Space Flight Enterprises share their unique facilities—both on ground and in orbit—with students, teachers, and faculty. The nine NASA Field Centers and the Jet Propulsion Laboratory implement national programs for high school, undergraduate and graduate students, teachers, and faculty while also providing Center-unique education programs that support their communities and states. Building on this foundation, NASA is poised to launch a bold new future.

In the past, NASA education programs have been structured around diverse sets of goals and objectives. To realize a new "One NASA" approach, the Agency has established specific strategic goals for education (goals 6 and 7, listed in table 3.1).

The Enterprise is working on two fronts to achieve these Agency goals. First, we are realigning our programs in accord with the Agency's strategic objectives and strategic outcomes for education (listed in table 3.1). In conjunction with this alignment, the Enterprise is working to ensure that student programs address NASA human capital needs with regard to critical skills and competencies, and directly or indirectly support new educational initiatives.

Second, the Enterprise is implementing a portfolio management approach to ensure that all education programs are aligned and coordinated. This approach includes: a portfolio inventory of all approved NASA education projects; a rigorous evaluation of proposed projects; periodic progress reports on performance metrics; annual performance evaluations using common criteria; and access to performance information for the entire portfolio. The portfolio management approach will provide information necessary for reallocation of resources and ensure a coordinated, nonduplicative set of activities that work together to achieve our education goals.

4.3 Evaluation and Research

The purpose of evaluation is to improve program activities and document outcomes. We will institutionalize evaluation as a core component of the NASA education strategy, making evaluation and data collection and analysis an integral part of the implementation of the Education Enterprise. A key aspect of our approach to evaluation is the implementation of a single Agencywide, Internet-based database in which all data derived from education programs are collected in a single system.

All new educational projects will be identified through open competition and undergo rigorous peer review to assess the quality of the proposed project and its alignment with NASA goals and objectives and Enterprise operating principles.

To ensure that sufficient resources are available to conduct high-quality evaluations, a designated portion of program fiscal resources will be devoted to evaluation activities. These resources support the maintenance of the evaluation database, the implementation of external evaluations of selected programs, and other evaluation activities as necessary.

Through linkages with other education organizations, NASA supports research in the areas of student performance and evaluation. The Education Enterprise works to generate new knowledge and approaches to effective NASA-related STEM instruction. The Enterprise also supports pilot-testing and initiatives to track the success of NASA education.

An Education Program Management Council (EPMC) will be established and composed of an internal group of NASA senior education man-

agers. The EPMC will approve new programmatic initiatives and periodically will review the performance of NASA education investments. The EPMC will provide recommendations to senior management based on its reviews.

The Education Enterprise will acquire independent advice primarily through the establishment of an Education Advisory Committee (EAC). The EAC, part of the NASA Advisory Council, will advise the Education Enterprise on program priorities and planning and help the Education Enterprise structure its future direction and assess its progress.

4.4 NASA Education Strategic Initiatives

NASA is taking bold steps to realize its Mission to "inspire the next generation of explorers." Building on previous accomplishments, NASA has established four strategic initiatives for education. These "pathfinder" initiatives, now in the early stages of implementation, are designed to stimulate student, educator, and public interest in science, technology, engineering, and mathematics through NASA-sponsored educational opportunities.

NASA Educator Astronaut Program

This "pipeline" strategic initiative exemplifies the Education Enterprise's commitment to inspiring and motivating students and educators on a national scale. Through the Educator Astronaut Program, NASA will add three to six elementary and secondary teachers as permanent members of the Astronaut Corps in 2004. Educator Astronauts will provide new content, advanced technological tools, and other educational services such as direct participation in space research and interaction with NASA scientists, engineers, and astronauts. These educators will help develop innovative teaching tools and new activities based on their training, flights, and expertise. The interactive activities and standards-based content created by the Educator

Barbara Morgan, and the Educator Astronauts who will follow her, will bring the excitement of space flight and the importance of science, technology, and mathematics to the Nation's teachers and students.

Astronaut Program are designed to motivate K-12 students from diverse communities to pursue science and mathematics courses and ultimately college degrees in STEM disciplines.

"Few things catch the imagination of young people as readily as the space program."

—NASA Administrator Sean O'Keefe

The Educator Astronaut Program leverages resources through the Education Enterprise's other national programs and the Centers' education and outreach programs to reach and include thousands of students and teachers. More than 80 non-governmental organization (NGO) partners help the Educator Astronaut Program disseminate and create appropriate content for local and regional areas.

Barbara Morgan, the first Educator Astronaut, is assigned to a future Space Shuttle flight. Morgan participated in multiple educator conferences around the Nation since the program's launch in January 2003. She will continue to participate in educational activities and programs until her mission training schedule begins. During the flight, Morgan will participate in multiple live educational programs via downlinks from the Space Shuttle and the International Space Station. Post-flight activities will be extensive

and closely coordinated with NASA's Office of Public Affairs to maximize exposure to the new educational content created from Morgan's mission and flight experience.

The Educator Astronaut Program will develop activities specific to mission objectives in partnership with a national textbook publisher. Activities will be posted on the *edspace.nasa.gov* Web site subsequent to and during the time of this flight. Similar educational activities will be coordinated with all future Space Shuttle and International Space Station crews. Students and teachers will also have the opportunity to gain hands-on experience with other NASA flight programs.

The Educator Astronaut candidates will participate in the development of educational products before, during, and after their training and flights. Candidates will attend national educator conferences to share new standards-based activities and tools available through NASA. The experiences of Educator Astronauts will be recorded and shared with the public, students, teachers, and the Earth Crew.

Earth Crew is an exciting, interactive program linking students, teachers, and the public to space-related educational activities via the *edspace.nasa.gov* Web site. Earth Crew members interact with NASA on ground-based projects and meet NASA astronauts and employees through Webcasts, other distance-learning activities, and live programs around the Nation.

The Educator Astronaut Program is customer-focused with a strong feedback component to better evaluate the content as the program grows and evolves. On the Web site, students and teachers are asked to provide their priorities for the types of activities and Webcasts in which they would like to participate. The public and family-oriented Earth Crew teams are invited to give feedback on all mission assignments and propose science experiments in which they could participate during Educator Astronaut flights or other NASA missions.

NASA Explorer Schools (NES)

This "pipeline" strategic initiative promotes and supports the incorporation of NASA content and programs into science, technology, and mathematics curricula in classrooms across the United States. Targeting underserved populations in diverse geographic locations, NASA Explorer Schools (NES) will bring together educators, administrators, students, and families in sustained involvement with NASA's education programs.

"Our renewed focus on education means not only inspiring our youth but also providing educators with the tools they need to teach math and science and to improve the country's scientific literacy—and we have those tools available today."

—NASA Administrator Sean O'Keefe

Teams of teachers, a school administrator, and a state curriculum supervisor develop and implement a 3-year action plan to address local challenges in science, technology, and mathematics education. This customized professional development plan will be based on needs assessments and delivered through on-site school services and via distance learning networks. Program elements for the NASA Explorer Schools include:

- Summer professional development workshops for teams of teachers and school administrators at the nine NASA Field Centers and the Jet Propulsion Laboratory; one week of intensive training provides opportunities to begin integration of NASA content into existing school curricula and culminates in the development and implementation of action plans to meet local education challenges

- Ongoing research-based professional development during the school year, in collaboration with organizational partners and other Federal agencies; this activity, coordinated by a network of teacher leaders and trainers, includes NASA aerospace education specialists, Space Grant consortia, educator resource centers, and NASA Education Enterprise networks

Engaging students with our unique mission, people, and facilities, such as talking with the on-orbit ISS crew by amateur radio, provides an educational experience as only NASA can.

- Student programs that provide opportunities for active participation in research, problem solving, and design challenges relating to NASA's missions and involve students in STEM explorations to encourage the use of scientific tools and methods; challenges will be grade-specific, supporting national and state standards. In addition, in-flight opportunities and competitions will provide access to unique NASA resources and personnel

"Dream how technology can not only improve education but also transform what we think of as education."

—U.S. Secretary of Education Rod Paige

- The *explorerschools.nasa.gov* Web site includes NASA resources; science, technology, and mathematics investigations; collaborative tools; and opportunities to share student and school program results

- A grant to each school will support the purchase of technology tools, online services, and inservice support for the integration of technology applications to engage students in science and mathematics investigations

- Family involvement in student educational growth, achievement, and career exploration is the responsibility of the NES teams locally for school and home experiences developed in cooperation with NASA assets; online opportunities will be available through the *explorerschools.nasa.gov* Web site

Competitive applications and selection of the NES teams occur each spring. Fifty teams will be added each year, for a total of 150 teams by 2005 with an accompanying expansion of supporting coordination personnel, professional development elements, and student opportunities.

NASA Explorer Institutes

Scheduled for implementation in 2004-2005, this "pipeline" strategic initiative will broaden NASA's reach to students, their families, and the general public. NASA Explorer Institutes will provide engaging NASA experiences and information to the informal education community, including science centers, museums, planetariums, and community-based organizations.

NASA Science and Technology Scholarship Program (STSP)

This "workforce development" strategic initiative directly supports enhancement of the STEM pipeline. STSP, currently under development, will provide scholarship opportunities for students in each of the three major components of the undergraduate student research pipeline—research universities, research colleges, and community colleges. Students with high achievement in the areas of science, technology, engineering, or mathematics who are selected for this program will receive full college tuition in exchange for a commitment to work for NASA or one of its affiliates. NASA is working presently with the appropriate congressional committees to develop the legislative authority required for full implementation of this initiative.

Hands-on laboratory research gives students experience in the NASA working environment.

Education Enterprise Strategy

"ONE NASA" EDUCATION

Our approach . . .

- Integrate student programs into a seamless pipeline
- Continue student affiliation
- Achieve program excellence
- Expand the pool of human capital

to achieving our objectives . . .

- Increase elementary and secondary participation
- Enhance higher education STEM capability
- Increase underrepresented and underserved participation
- Expand e-Education
- Expand informal education participation

in implementing this Strategy . . .

- Define education roles and responsibilities
- Restructure programs and manage the portfolio
- Institutionalize evaluation
- Implement "Pathfinder" initiatives

results in the achievement of our goals!

- Inspire and motivate students
- Engage the public

5 Beyond the Horizon

5 Beyond the Horizon: Seeing Learning in a Whole New Light . . .

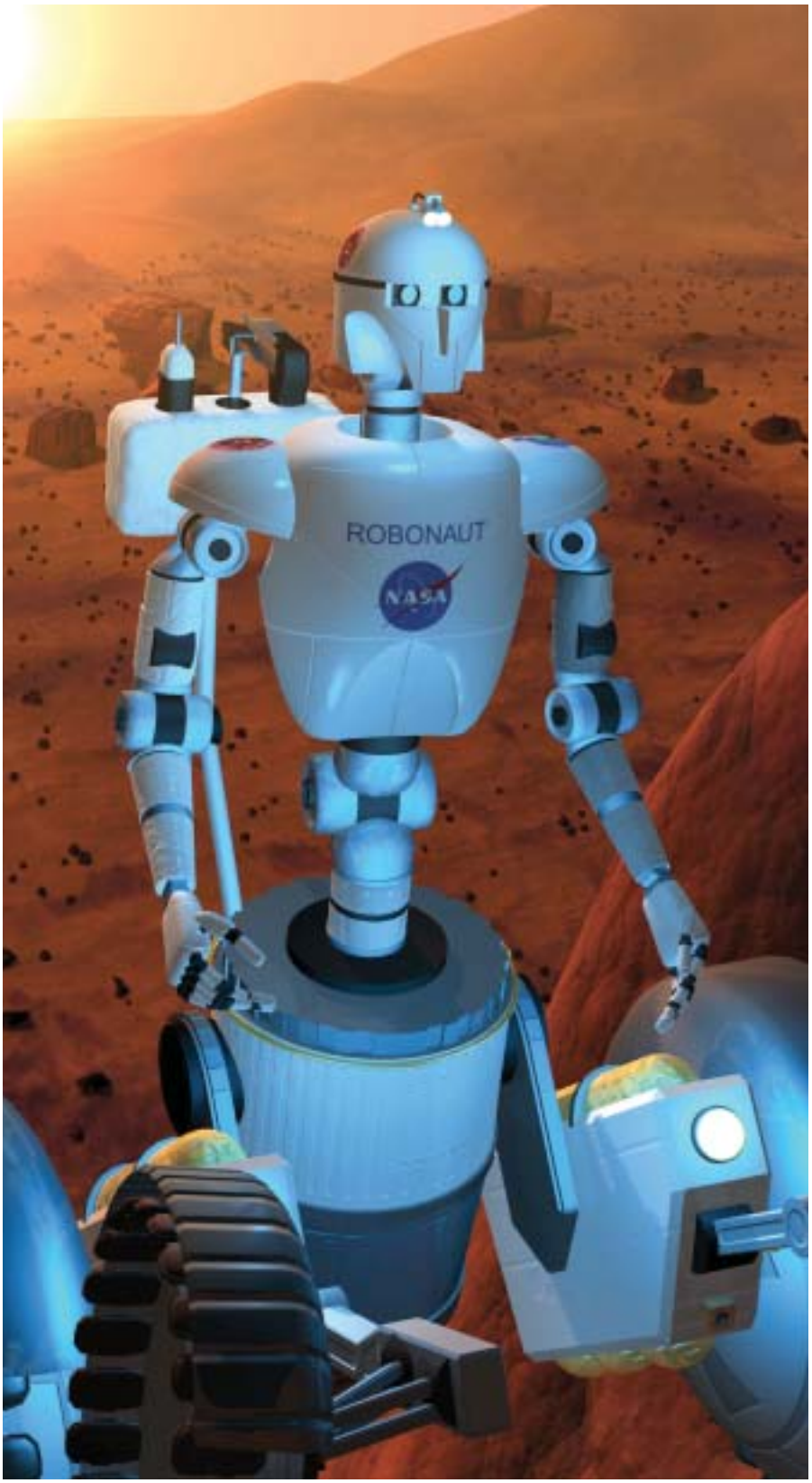
Let's fast forward to the year 2025. NASA's education goals have been achieved. Imagine how technology, NASA research and discoveries, and Education Enterprise programs have inspired and motivated the next generation of explorers.

As NASA sought to fulfill its Vision and Mission, our worldview has been transformed by newly acquired knowledge and evolving technologies. This world contains transport systems for students to virtually travel beyond Earth to observe comets, and education has evolved into a learning environment without walls. The NASA Explorer Schools model has evolved into the classroom of 2025. Learning is delivered on demand. Students and educators receive what they need, when they need it—anytime, anywhere.

"Our mandate is to pioneer the future . . . to push the envelope . . . to do what has never been done before."

—NASA Administrator Sean O'Keefe

Powerful technologies have enabled new learning environments using simulations, visualizations, immersive environments, gameplaying, intelligent tutors and avatars, learner networking, and usable building blocks of content. These capabilities have created rich and compelling learning opportunities that meet the needs of learners while empowering educators to unlock the potential in each student's heart and mind. The NASA of 2025 has united with the technology and education communities in dialogue, understanding, and action. The students and educators of the future are securing a new renaissance of learning for the benefit of the Nation and the world.



Classroom 2025

Students geographically dispersed from around the Nation prepare to embark on a mission of exploration in their science classroom of 2025. The room is transformed into a full-immersion aural and visual environment, making it appear as if they are all physically in the same location. Like astronauts performing work onboard the International Space Station (ISS), the students move through a compelling landscape of continuous activity. Together they perform remote-based experiments on the moon. As they move through the process of scientific inquiry, they are inspired to ask questions of each other, their teacher, and their NASA virtual mentor as they explore fundamental principles and develop robust models of complex systems.

Students utilize hand-held, wireless, electronic notepads and Personal Digital Assistants (PDAs) with the power of today's supercomputers. Students are engaged in global learning groups. Textbooks are digital, and information is available in real time. Embedded technologies measure performance and provide immediate and secure feedback to the student, teacher, and parent. Intelligent tutoring services are available on demand. Technology enhancements have reduced barriers to allow those with auditory, visual, or physical challenges to fully participate in the learning experience with their peers. These students cannot imagine what learning was like before augmented reality and ubiquitous computing.

Classroom 2025 at every grade level has utilized technology to transform the learning environment and greatly expand the potential of all education stakeholders—students, educators, parents, and communities. Classroom 2025

lets me **go** somewhere I have not gone,

lets me **meet** someone I have not met,

lets me **do** things I have not done

. . . but can **with NASA!**

Image credit: John Frassanito and Associates

Classroom 2025 Students

Classroom 2025 has leveraged collaborative technology networks, which NASA and its strategic partners have established, to bring children together. Whether children are working on art or science, they work with embedded technology. Group communication is the core objective with shared activities as the principal methodology.

NASA digital libraries contain myriad "volumes" of video, graphics, and data resources, as well as personalized learning resources, making education a dynamic and continuous process. Students are conducting complex research and simulations with a few keystrokes or touches to a screen. Digital highlighting, digital conversations, group note-taking, and other personal annotations are normal and widely used in the educational process.

Imagine . . .

Student Planetary Exploration.—A "fleet" of 50 small rovers is deployed on the surface of Mars. High school student teams, assisted by NASA and university learning facilitators, compete to make the most significant discoveries on the surface using on-board sensors tied to NASA-supported telepresence technology. Geographic boundaries between students are displaced by shared technologies, and communities and families benefit from the work of the teams and the important planetary exploration research being accomplished.

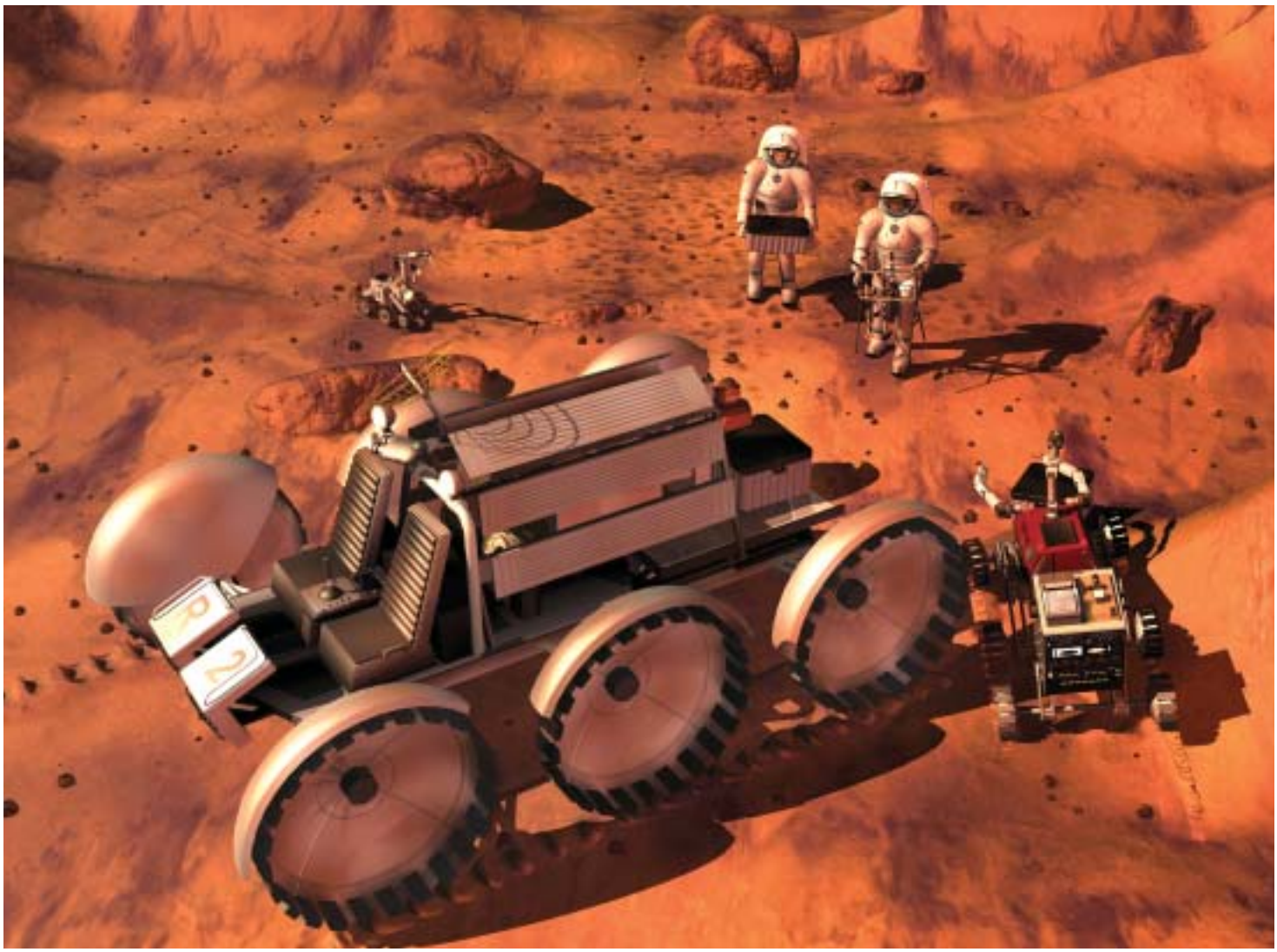


Image credit: John Frassanito and Associates

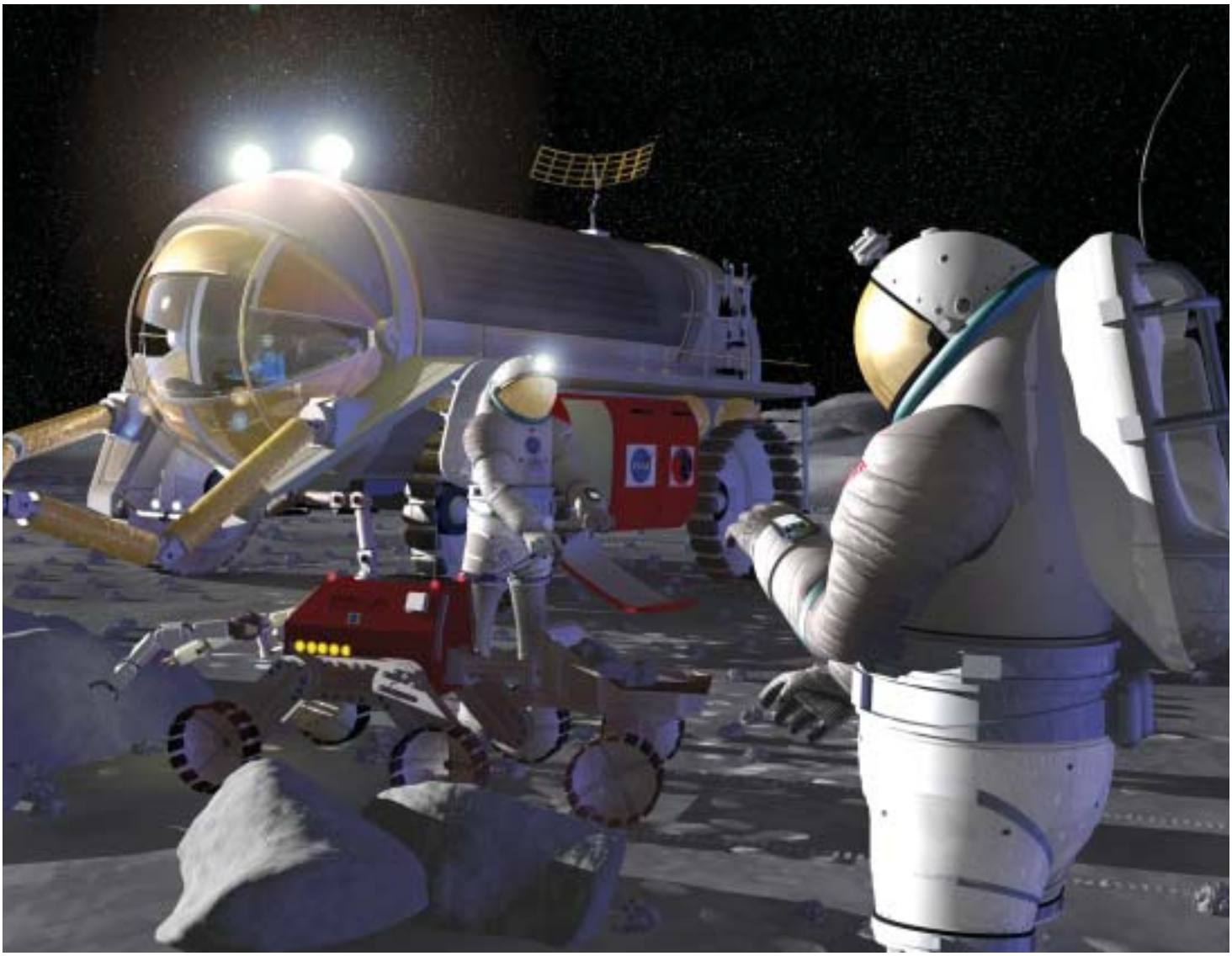
Classroom 2025 Teachers

Teachers, working as professional facilitators both locally and virtually for individual students, are able to draw upon a variety of NASA learning products and services to enhance their instruction. Virtual forums allow teachers to share their activities, insights, and technology ideas with NASA, university, and industry experts in the fields of science, mathematics and engineering. Families are an integral part of the learning community.

Imagine . . .

Virtual Vision.—Sight-impaired students are able to experience the wonders of NASA through a sonar and translation matrix that enables these students to interpret audio signals to "see" the International Space Station (ISS) environment in 3D and participate in scientific research being done on this remote laboratory. By wearing a sonar sound set, sight-impaired students can walk virtually through the ISS, access datasets, and perform experiments. Wireless haptics interfaces, similar to those used by astronauts in training, further enhance the experience by creating virtual touch sensations. Imagine educators being able to work together with NASA researchers to make NASA experiences available to all children, including those with physical limitations.

Image credit:
John Frassanito
and Associates



Higher Education 2025

The Nation's higher education network is a primary contributor to the accomplishment of the NASA Mission. An increased emphasis on student research as a motivating learning experience enables student-faculty team problem solving. NASA supports networks in which university teams access universal space-community databases and employ state-of-the-art computer assets to generate multiple solution scenarios. The result is rapid access to both collaborative and parallel research findings from the best Earth-based and space-based labs. Because NASA challenges transcend the traditional boundaries of scientific and engineering disciplines, omni-disciplinary NASA teams—which include the campus assets—meet in virtual environments to analyze and evaluate the possible approaches. These collaborative research-environment team meetings include personnel throughout the many NASA and university locations, both terrestrial and in space. They meld the new ideas of the students, mentored by faculty unfettered by terrestrial confines, with the experiential wisdom of the senior personnel.

In 2025, NASA's integration of higher education assets into the NASA problem-solving process leads to faster and more informed decisionmaking. At the same time, incorporation of higher-education assets assures a source of highly trained, knowledgeable, and motivated workers for both present-day and future challenges.

Imagine . . .

Virtual Mentors.—Sumi, a NASA student researcher, talks to a visual display on the wall and greets her NASA virtual mentor. She then logs into the desktop videoconference system that connects her with the rest of the research team, comprised of NASA researchers and other undergraduate students who are located around the Nation. The virtual team begins work for the day in the collaborative NASA workspace, discussing the results of recent experiments and next steps in the research plan. Sumi pauses her video session to consult her virtual mentor for clarification on some data results. The virtual mentor responds in detail and also provides a short digital video on the topic which can be viewed immediately.

Lifelong Learning 2025

In 2025, NASA missions continue to inspire the American public, and NASA discoveries are highlighted in museums, science centers, and the news and entertainment medias. New technologies allow for NASA-sponsored virtual tours, field trips, and vacations. Families use robotic partners to travel at the speed of light on virtual camping trips to remote points in the universe. Citizen explorers young and old are able to explore new planets by studying geography, soil composition, texture, weather systems, and astronomy. They learn new languages and new paradigms of thinking and living that are beyond what we can imagine. Learning has become a lifelong experience filled with limitless opportunities.

Students have unprecedented opportunities to engage in NASA flight programs, the observation of distant galaxies, and the robotic exploration of distant planets. A new, diverse generation of explorers is entering the science and engineering professions in numbers not seen since the 1960s. Empowering this growth, America's teachers and faculty have access to the latest teaching and collaborative tools and computer resources. Mission experiences link their students and classrooms to NASA's diverse personnel, research facilities, orbiting space stations, telescopes, lunar outposts, and planetary probes.

In this visionary glimpse of the future, our successful efforts to "inspire the next generation of explorers" have provided a continuous pipeline of scientists, technologists, engineers, mathematicians, and teachers to carry forward our Nation's exploration goals. We have seen and experienced learning in a whole new light.

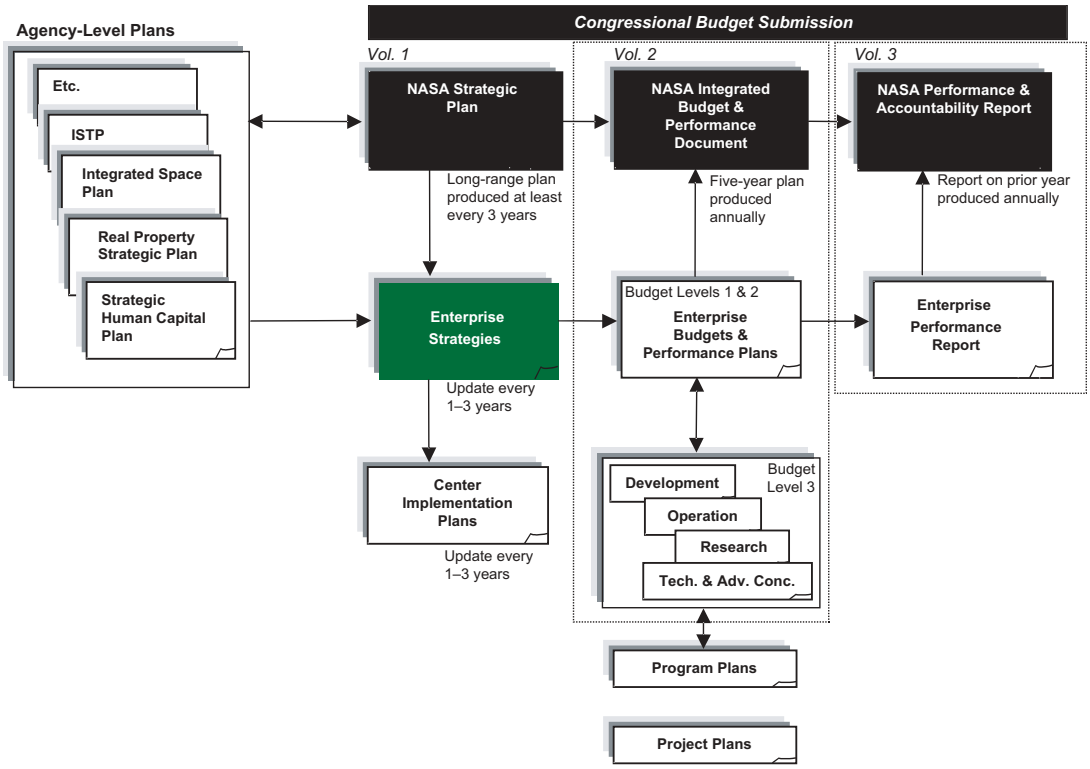
Appendices

Appendix 1

Relationship to Agency Planning

The Agency's planning process includes the development of a Strategic Plan, the annual budget, and a performance plan. The Strategic Plan is a 5-year plan, updated every 3 years, that defines the Agency's goals and objectives. The NASA Enterprises base their planning on the strategic emphasis, implementing strategies, goals, and objectives outlined in the Strategic Plan. In addition, Enterprise budget planning and performance reporting are directly traceable to the Agency-level documents.

The Enterprise Strategy communicates the results of the Agency and Enterprise planning processes to the NASA stakeholders and other audiences listed below.



Stakeholder/Audience	Enterprise Strategy Function
Executive and Legislative Branches	Communicate purpose and value of investments
NASA Employees	Achieve alignment within the Enterprise and Agency
Other NASA Enterprises	Strengthen inter-Enterprise collaboration
Science Community	Document consensus on objectives and priorities
Contractor Community	Communicate programmatic objectives and priorities
Interagency, International, and Commercial Partners	Establish basis for future collaborations
The Public	Inform and inspire

Appendix 2

Principal Enterprise Partnerships

Space Flight Enterprise

- Functional and operational requirements for new technologies
- Spaceport launch facilities
- Integrate payloads
- Conduct experiments on the Space Shuttle and on the ISS
- Service space telescopes
- Launch robotic spacecraft on expendable launch vehicles
- Rocket propulsion testing
- Communications and data services
- Education and public outreach programs

Aerospace Technology Enterprise

- Advanced technology development and transfer
- Aerospace Technology Enterprise assets
- Systems analysis capabilities
- Technology problem-solving expertise
- Commercial technology transfer to Enterprises
- Orbital Space Plane
- Airborne sciences
- Education and public outreach programs

Space Science Enterprise

- Functional and operational requirements for new technologies
- Functional and operational requirements for launch vehicles
- Manage Deep Space Network
- Manage optical communications development
- Manage Astrobiology Program
- Provide space weather data
- Education and public outreach programs

Biological and Physical Research Enterprise

- Functional and operational requirements for new technologies
- Functional and operational requirements for launch vehicles and ISS
- Biomedical research
- Operational protocols
- Physical science design and safety standards
- Data measurement for Mars related to sustainable human presence and safety
- Education and public outreach programs

Earth Science Enterprise

- Functional and operational requirements for new technologies
- Functional and operational requirements for launch vehicles
- Study of Sun-Earth connection
- Adapt Earth system models to other planets
- Assist in improving aviation safety
- Study effects of global change on human health
- Ground network services
- Education and public outreach programs

Education Enterprise

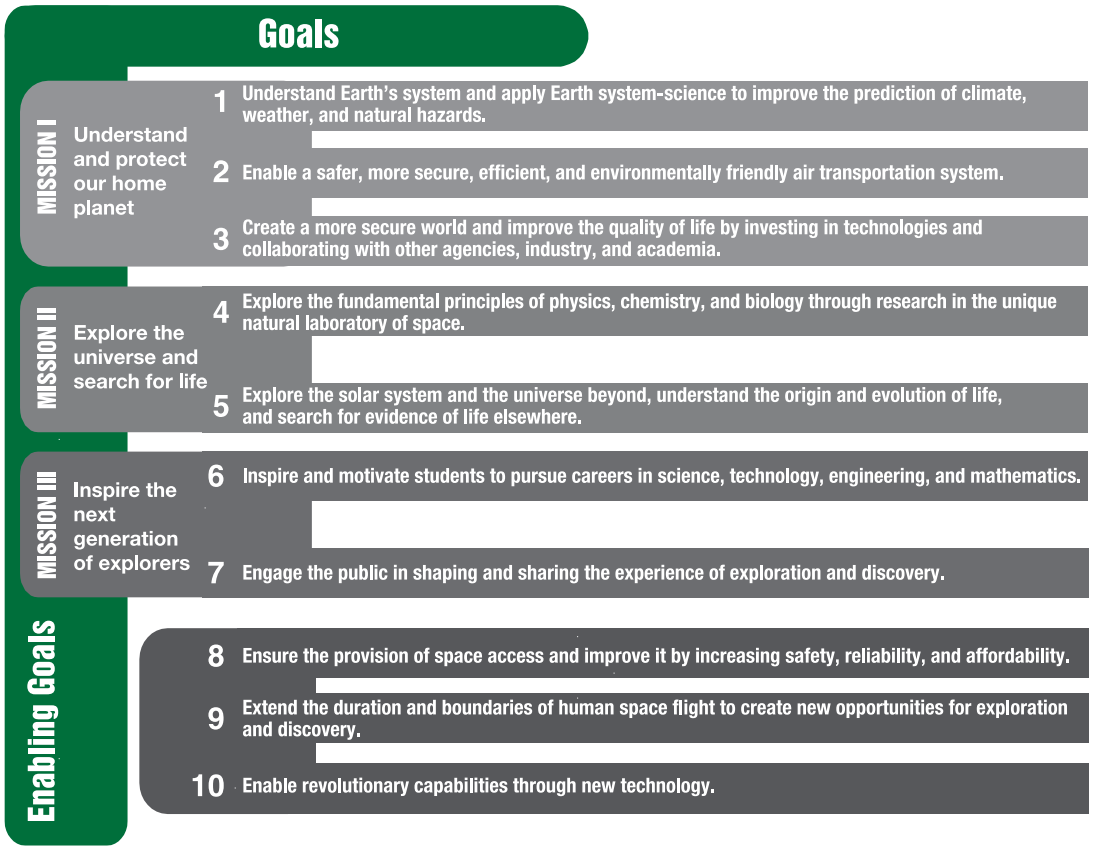
- Guidance and integration of other Enterprises' education programs
- Linkages of NASA education programs to other Enterprises' future competencies and skill requirements
- Public outreach programs

Key

- Supports Space Flight Enterprise
- Supports Aerospace Technology Enterprise
- Supports Space Science Enterprise
- Supports Biological and Physical Research Enterprise
- Supports Earth Science Enterprise
- Supports Education Enterprise

Appendix 3

NASA Strategic Goals



NASA Core Values

Safety.

NASA's Mission success starts with safety. A commitment to safety permeates everything we do. We are committed to protecting the safety and health of the general public, pilots and astronauts, the NASA workforce, and our high-value assets on and off the ground.

People.

Our greatest strength is our workforce, a team of highly qualified individuals that is representative, at all levels, of America's diversity. We foster a culture of trust, respect, teamwork, communication, creativity, equal opportunity, and empowerment.

Excellence.

We are committed to excellence. We continuously improve our processes, products, and services to better serve our customers.

Integrity.

We are honest and ethical in all that we do. We deliver on our commitments, and we are accountable for our performance.

Appendix 4

Glossary of Terms

APGs	Annual Performance Goals
Avatar	An electronic or virtual embodiment or manifestation for role-playing in an interactive and immersive digital environment.
Digital Content	The digitized multimedia material that calls upon students to seek and manipulate information in the collaborative, creative, and engaging ways that makes digital learning possible. It includes video-on-demand, software, CD-ROMs, Web sites, email, online learning management systems, computer simulations, streamed discussions, data files, databases, and audio.
Digital Learning	Educational approach that integrates technology, connectivity, digital content and human resources.
Diversity	A management philosophy and core value for maximizing potential, at both the individual and organizational levels, by fostering awareness, understanding, and respect for individual differences and by capitalizing on the knowledge, expertise, and unique background and lfie experiences offered by each individual, including, but not limited to, ethnic, gender, racial, religious, and cultural identity
e-Education	An umbrella term for high quality, content-rich, just-in-time, technology-mediated learning experiences that are customizable and can occur anywhere access is available.
Enterprise	Primary business areas for implementing NASA's mission and serving customers. The NASA Enterprises are Aerospace Technology, Biological and Physical Research, Earth Science, Education, Space Flight, and Space Science.
evaluation	The systematic investigation of the merit or worth of an object.
informal education	The process of acquiring new knowledge and skills without the benefit of structured teaching. An educational setting that encourages and facilitates self-directed learning.
ISS	International Space Station
Minority	Individuals whose race/ethnicity is classified as American Indian or Alaska Native, Asian, Black or African American, Hispanic or Latino, Native Hawaiian or Pacific Islander.

NASA Field Centers	Ames Research Center (ARC), Dryden Flight Research Center (DFRC), Glenn Research Center (GRC), Goddard Space Flight Center (GSFC), Johnson Space Center (JSC), Kennedy Space Center (KSC), Langley Research Center (LaRC), Marshall Space Flight Center (MSFC), and Stennis Space Center (SSC). Jet Propulsion Laboratory (JPL), a Government-owned, contractor-operated facility.
One NASA	A concept that emphasizes a unified strategic plan, a strong commitment to teamwork, tools, and capabilities for greater collaboration across the Agency, and more efficient systems within the Agency. [*http://onenasa.nasa.gov*]
President's Management Agenda (PMA)	A strategy for improving the management and performance of the Government, making it more citizen-centered and results-oriented through five Government-wide initiatives: Strategic Management of Human Capital, Competitive Sourcing, Improved Financial Performance, Expanded Electronic Government, and Budget and Performance Integration. [*http://www.whitehouse.gov/omb/budget/fy2002/mgmt.pdf*]
R&D	research and development
STEM Pipeline	Education programs that provide talented and diverse students an educational pathway into targeted opportunities and experiences leading to careers in science, technology, engineering, mathematics, or teaching.
Science and Technology (S&T) Enterprises (NASA)	Aerospace Technology, Biological and Physical Research, Earth Science, Space Flight, and Space Science
STEM	science, technology, engineering, and mathematics
Systemic Reform (STEM)	Fundamental, comprehensive and coordinated changes in science, mathematics, and technology education through attendant changes in policy, financing, governance, management, content, and conduct. Systemic reform occurs when all essential features of schools and school systems are engaged and operating together; when policy is aligned with a clear set of goals and standards; when the forthcoming improvements and innovations become intrinsic parts of the ongoing educational system for all children; and when the changes become part of the school system's operating budget.

Underrepresented Minority Racial and ethnic populations that are underrepresented in the STEM profession relative to the size of the population at large. This term may encompass Blacks or African Americans, American Indians or Alaska Natives, Native Hawaiians or Other Pacific Islanders, and Hispanics or Latinos. The broader term "underrepresented" as opposed to "underrepresented minority" in the STEM arena refers to not only racial and ethnic populations, but also includes women and persons with disabilities because of the relative size of these groups to the total population at large. (see Olson, Kristen, NSF 99-320 Data Brief, Division of Science Resources Studies, January 15, 1999; See NSF Report on Women, Minorities, and Persons with Disabilities in Science and Engineering 2000).

Underserved The term "underserved" is often used interchangeably with "underrepresented," particularly as it relates to the sciences and engineering. Specifically, it provides access and opportunity to persons of diverse racial/ethnic, gender, religious, age, sexual orientation, disabled, etc. populations with limited access to decent and affordable housing, gainful employment, and other services. In the STEM arena, "underserved" has typically referred to women and persons with disabilities (see DOJ, Americans with Disability Act, 1990; Center of Excellence, Stanford University).

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